Paper 2: An introduction to the subhumid zone of West Africa and the ILCA Subhumid Zone Programme

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Abstract

Of all the ecological zones of Africa, the subhumid zone has the greatest potential for increased livestock production. It has therefore been a major focus of attention for the International Livestock Centre for Africa (ILCA). The zone has the capacity to support increased livestock numbers as well as higher productivity per animal. This potential is particularly apparent in Nigeria, where the relatively underutilized subhumid zone occupies about 50% of the country (455 000 km^2). The zone's high arable potential will be exploited primarily for food crop production. Researchers have traditionally considered cropping to be incompatible with livestock production. This is not true in practice, and future research must take the links between the two into account, particularly since pastoralists themselves are tending towards more settled agropastoralism.

There is considerable scope for increased cattle productivity through improved animal nutrition. Suitable interventions for small ruminants are more difficult to identify.

The objective of ILCA's research is to produce 'farmer-ready' techniques to pass on to national livestock development and extension agencies.

The research is conducted within a livestock systems research approach with diagnostic, design, testing and application/extension phases.

Introduction

In March 1979 the National Animal Production Research Institute (NAPRI) of Nigeria and the International Livestock Centre for Africa (ILCA) cosponsored a symposium on Livestock Production in the Subhumid Zone of West Africa. The symposium provided both a summary of the state of knowledge and guidance on the direction of future research to be undertaken by the ILCA Subhumid Zone Programme. It is now appropriate that the information gathered since 1979 be presented so that the state of knowledge and direction of further research can be re-assessed.

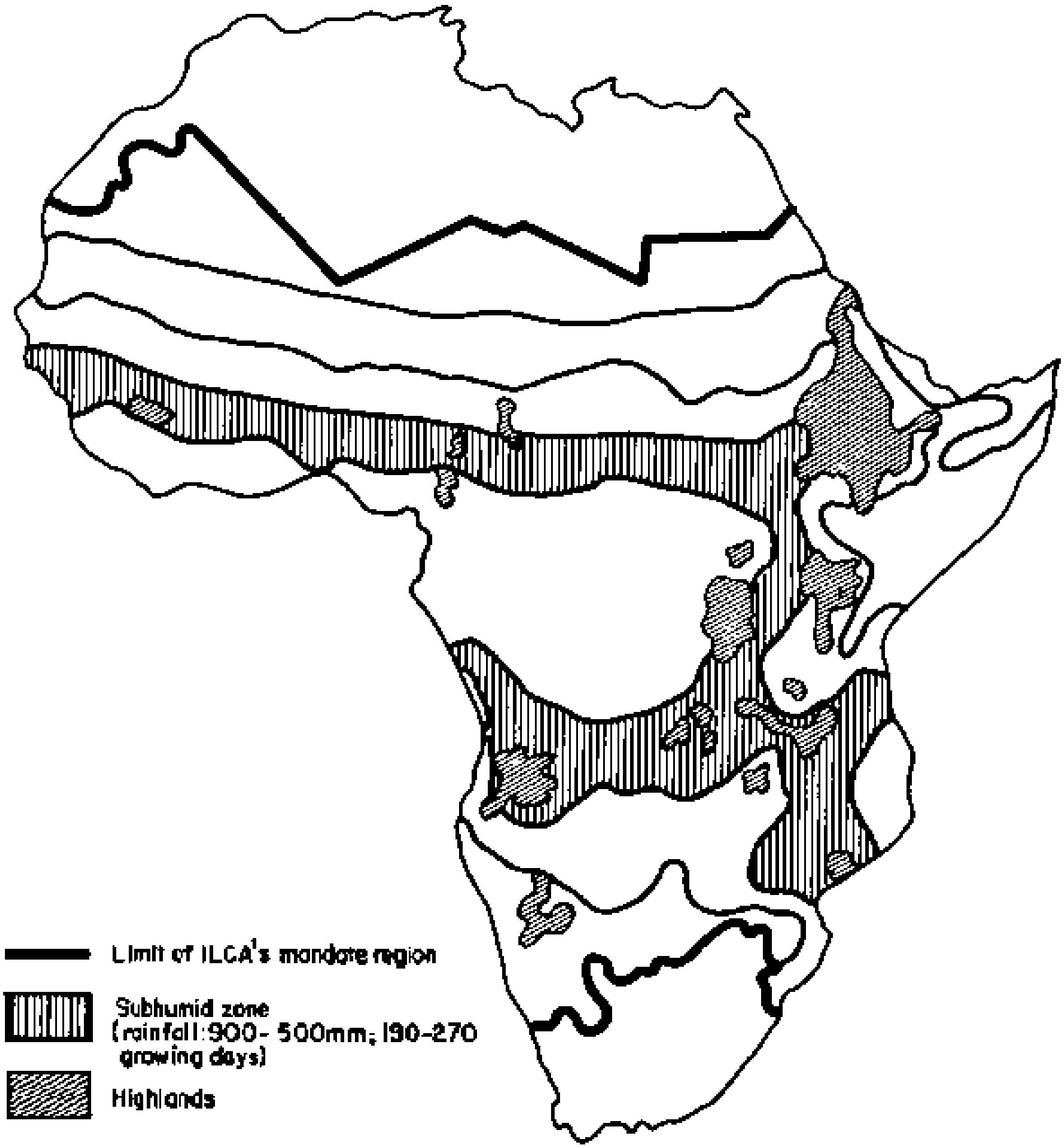
This paper provides an overview of the zone, and a background to the mere detailed papers that follow. It is in two parts: an introduction to the subhumid zone and an introduction to the

ILCA Subhumid Zone Research Programme. It indicates why ILCA is concerned with research in the zone as a whole and in Nigeria in particular. It also explains the research and development policies and institutions involved in the country's livestock sector.

General characteristics of the subhumid zone

The subhumid zone occupies some 5 million km^2 or 23% of Africa (Figure 1), with a rainfall of between 900 and 1500 mm per annum and a crop-growing period of between 180 and 270 days. It is inhabited by 25% of the people and supports 22% of the cattle, 13% of the sheep and 16% of the goats of Africa. In contrast, the semi-arid zone, with only 18% of the land area, supports 28% of the people and 30% of the cattle (Table 1). The heavy concentrations of people and stock on both its northern and southern borders suggest that the low populations in the subhumid zone cannot be accidental. As the constraints to occupation are lifted (Paper 5) and/or outside pressures mount further, there is accelerating immigration into the zone. In a continent short of food, it is somewhat anomalous that the agricultural research community has done so little to improve livestock production in the subhumid zone.

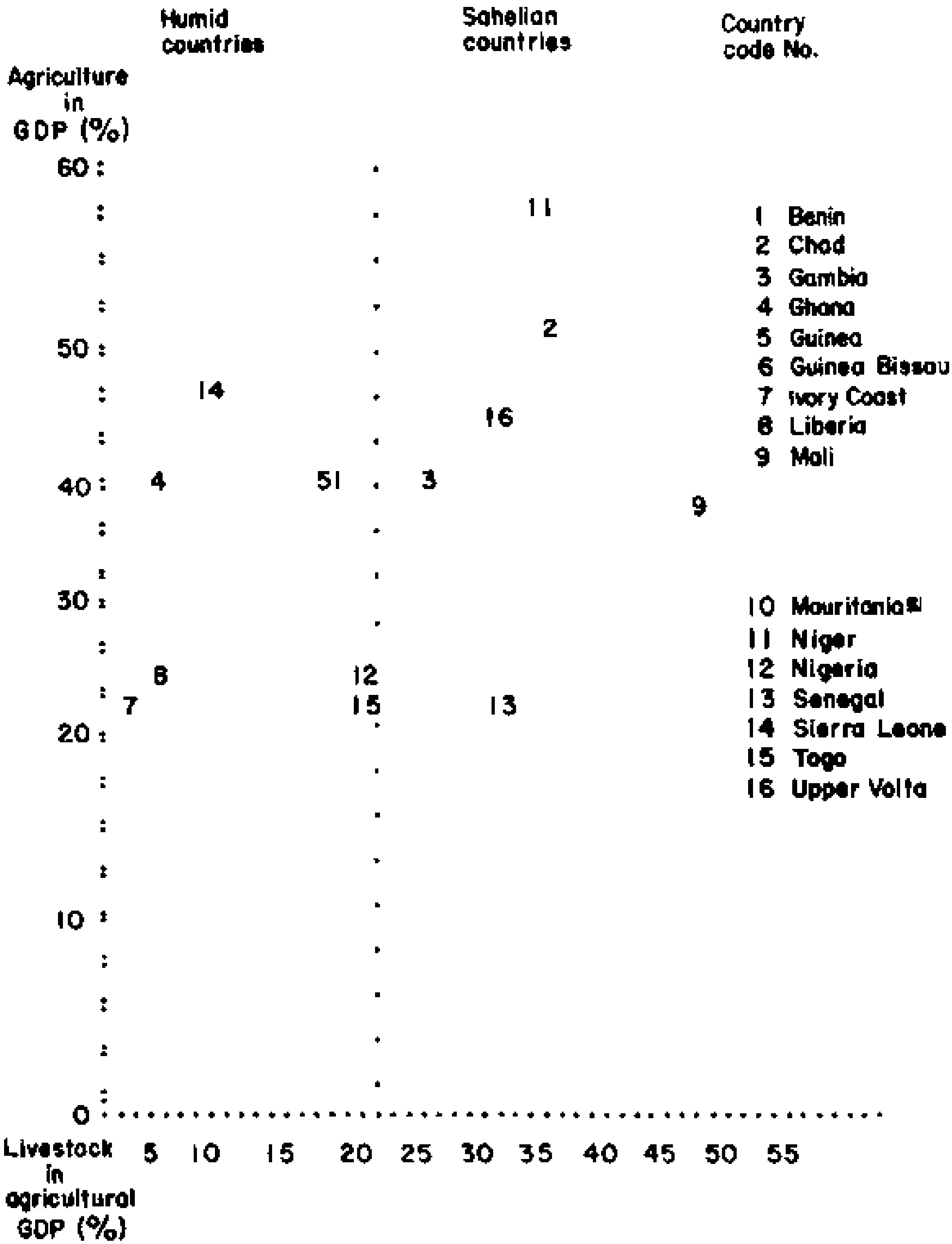
Figure 1. The ecological zones of sub-Saharan Africa.



Although the livestock subsector contributes a significant US$ 2 billion to the gross domestic product of West African countries, the region's 35 million ruminant livestock units cannot satisfy the needs of its 144 million people (Jahnke, 1982). By extrapolation from ILCA's herd productivity data the regional output is estimated to be 42 kg of milk and 15 kg of beef per head of livestock per annum. This is equivalent to about 0.2 g of protein/caput/day. On the same basis, the estimated 9.3 million cattle in Nigeria produce about 28 million kg of protein. Assuming a national population of 90 million people (Federal Ministry of Agriculture, 1981), that would allow 0.9 g of protein/caput/day, or in other words one tenth of the 8 g/caput/day required from livestock in a target of 34 g/caput/day from all food sources (Federal Ministry of Agriculture, 1981).

Livestock production in the region tends to be limited north of the subhumid zone by aridity and south of the zone by tsetse-borne trypanosomiasis. About half the land area of West Africa is arid, and the other half tsetse-infested (Jahnke, 1982). This statement is something of an oversimplification, since quite extensive areas have been cleared of tsetse infestation. Some countries are mere fortunate than others in their non-agricultural resources (such as oil in the case of Nigeria, for example) and in their stage of development. This is reflected in a reduced share of GDP produced by agriculture (Figure 2). It is noticeable, however, that all the Sahelian countries - Senegal, Gambia, Mauritania, Mali, Burkina Faso, Niger and Chad - feature on the right of Figure 2. Livestock are less important in other, more humid coastal states.

Figure 2. Proportion of agriculture in GDP and proportion of livestock in agricultural GDP in West African countries.



Source: Jahnke (1982)

a/

Mauritania is off the scale at 35% agriculture, of which 86% is from livestock.

Table 1. Human and animal populations of ecological zones of sub-Saharan Africa.

Zone	Land area (million km^2)	Humans	Cattle	Sheep	Goats
		(millions)			
Arid	8	25	32	37	48
Semi-arid	4	66	45	25	33
Subhumid	5	60	33	14	20
Humid	4	50	9	8	12
Highlands	1	38	29	24	12
Total	22	239	148	108	125

The countries of West Africa can be classified as primarily either producers or consumers of ruminant, particularly cattle, products. The drier countries have large cattle populations relative to their human populations; these include Mauritania, Mali, Burkina Faso, Niger and Chad. The converse situation of large human populations and relatively limited numbers of cattle exists in the humid coastal countries such as Ivory Coast, Ghana, Togo and Benin. An examination of the cattle statistics for the various states within Nigeria by Milligan et al (1978) found that Nigeria's situation was in line with the regional trend, showing greater numbers in the drier states.

These varying numbers of livestock must inevitably lead to different approaches to development. The coastal states might, for instance, be expected to opt for 'modern' commercial production with an emphasis on intensive finishing operations such as the Ferkessedougou and other feedlots in Ivory Coast (Delgado and Staatz, 1980). The traditional cattle-producing countries will, on the other hand, be more interested in raising the productivity of traditional pastoralism. Most countries will, however, have some desire to stratify production according to the peculiar merits of each ecological and economic zone (Ariza-Nino et al, 1980).

Nigeria is a good regional case study because in many ways it is demonstrating the paths other countries in the zone are likely to follow (FAO, 1984). Though it has a large national herd of some 9.3 million head, the demand for milk and beef still greatly exceeds supply. About 60% of cattle movements across national boundaries in West Africa involve cattle destined for Nigerian markets. Nigeria has also tried most of the familiar development strategies, such as grazing reserves, ranches, dairy farms and feedlots.

Most significantly, however, the pastoralists and the government are becoming increasingly interested in the possibility of increased production through the occupation and development of the country's subhumid zone. By 1976 tsetse eradication programmes had covered over 210 000 km^2 of Nigeria, thus effectively doubling the area of land free of tsetse fly. These programmes, involving various means of spraying and biological control, are increasingly moving into the subhumid zone (Federal Ministry of Agriculture, 1981). This movement is consistent with the government's policy for relocating in the subhumid zone a major portion of the national herd from the overstocked arid zones (David-West, 1980).

Meanwhile the pastoralists themselves have been gradually changing their traditional ways. Instead of using the subhumid zone only in the dry season and moving out as tsetse populations spread north during the wet season, they are increasingly using the zone as their permanent home. Van Raay (1974) estimated that about half the Fulani in Nigeria are at least semi-settled, and the trend towards settlement is continuing. The density of cattle in four typical areas of the Nigerian subhumid zone indicates extensive permanent settlement there (Table 2).

Table 2. Cattle densities in four case study areas in the Nigerian subhumid zone.

	Area (km^2)	Density (head/km^2)	
		Dry season	Wet season
Kurmin Biri	2500	17.3	4.2
Abet	2475	37.4	22.7
Mariga	2750	6.6	23.5
Lafia	3500	12.7	37.7

Source: Milligan (1983).

The latest estimate of 4.5 million cattle in the zone (Bourn and Milligan, 1983) is very much higher than the previously accepted figure of 2.28 million (Jahnke, 1982). This new figure suggests that there has been a significant increase in cattle numbers in the zone in Nigeria, and it is most likely that the trend is the same throughout the whole zone in West Africa (Oxby, 1982). Whilst the international community has been focussing its attention on the plight of the Sahelian countries, a major restructuring of the regional livestock industry is occurring largely unappreciated, unaided and very much under-researched. The growing demand for livestock products and the restrictions imposed by tsetse and aridity in other areas emphasize the importance of livestock research for development in the subhumid zone.

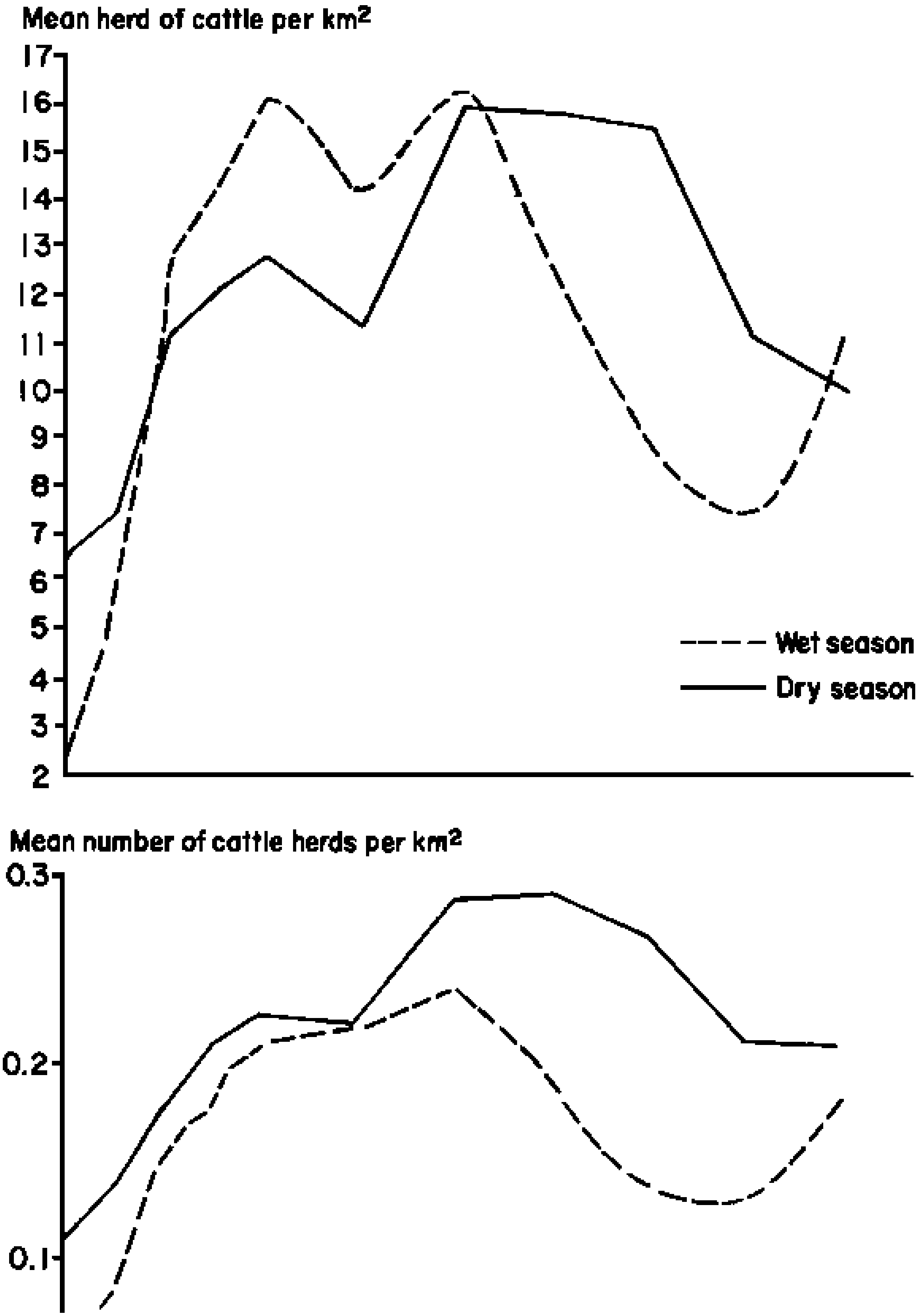
The pastoral communities have not been moving in alone. Arable farming communities have been spreading in from the north and south, as well as expanding within the zone (Bourn and Milligan, 1983).

Oxby (1982) and others have pointed out that the settlements of arable farmers and pastoralists are physically, economically and socially related. This close proximity of farming and pastoral communities implies same degree of integration between crop and livestock production. Van Raay (1974) cited deferred grazing of the pastoralists' own crop residues and the corralling of cattle an their fields as instances of deliberate integration of the two production systems. He also analysed the relative advantages of settlement, and concluded that settled pastoralists with good access to crop residues had better changes of meeting their herds' nutritional requirements than did nomadic pastoralists.

Cereal farming communities normally appreciate cattle food products and the manure and draught benefits obtainable from cattle. The pastoralists appreciate the benefits of crop residue grazing, and subsistence cropping is increasingly important to their well-being. They thus have the same ecological and market needs as the arable farmers and will tend to congregate within or on the periphery of farming communities (Okali and Milligan, 1981).

With rapidly growing human populations and critical shortages of foreign exchange, domestic food crop production is the highest national priority. The logical outcome of this priority is that all potentially arable land will eventually be utilized for crop production As a result of this argument there is a tendency in same quarters to lower the priority or even deny the need for livestock development. That is a false and retrogressive conclusion on two counts (von Kaufmann, 1983a). Firstly, ruminants can convert feedstuffs that human beings cannot eat into high-value human food. They can not only utilize the vegetation from non-arable and fallow land but also the dry matter (LM) produced by crops but not harvestable as grains or other human food. Bywater and Baldwin (1980) demonstrated that, even if some grain is required to tap up cattle rations, human food to human food conversion efficiencies of ever 100% are obtained. Secondly, cattle densities in the subhumid zone have been found to increase with increasing cultivation until 50% or more of the land is cultivated (Figure 3) (Bourn and Milligan, 1983). Since at the present time cultivation rarely averages more than 25% of the available land, there is room for considerable expansion of cattle numbers in the subhumid zone (Figure 4).

Figure 3. Variation in cattle density, herd density and herd size with land-use intensity in the Nigerian subhumid zone



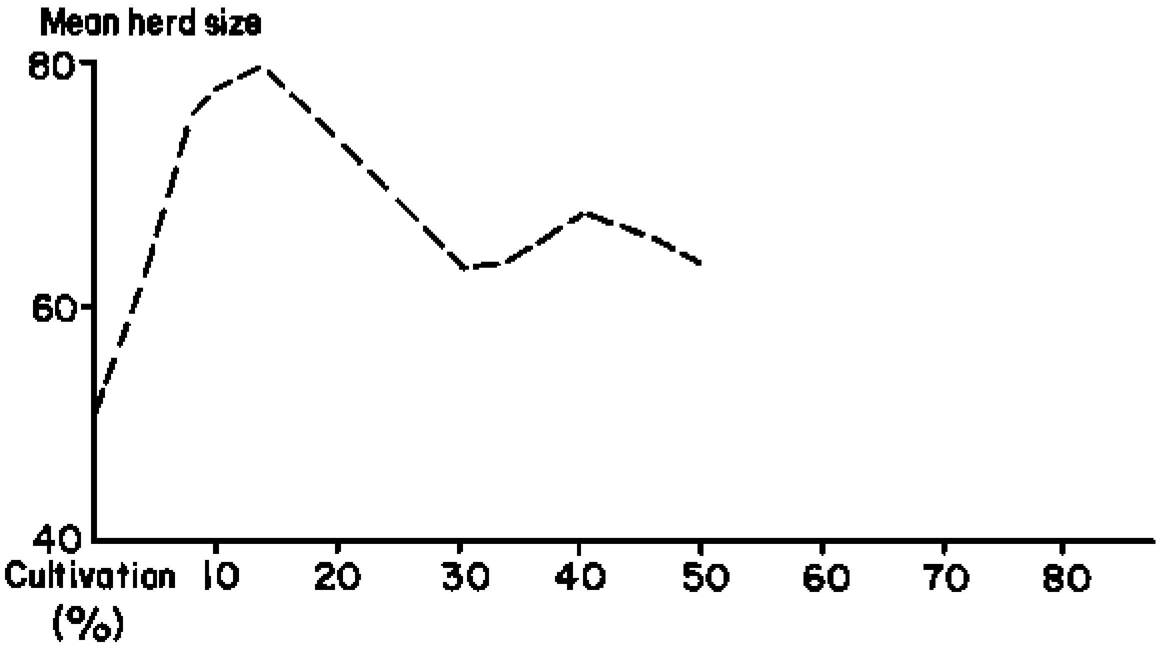
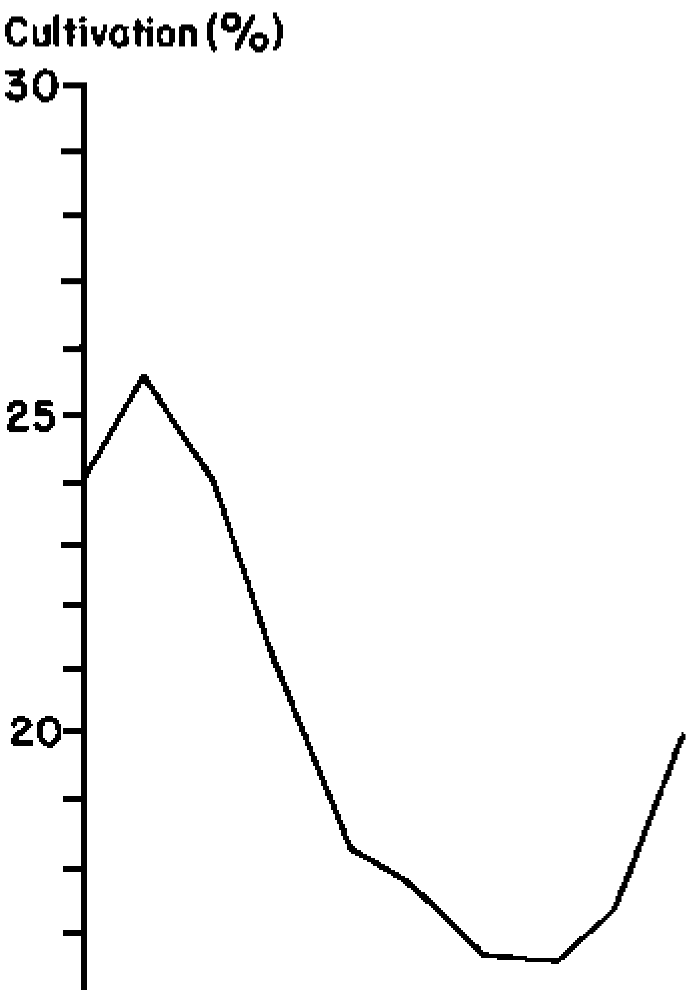
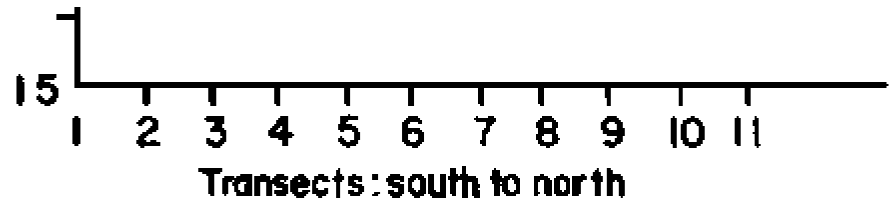


Figure 4. Geographical components of land-use intensity gradients in the Nigerian subhumid zone.





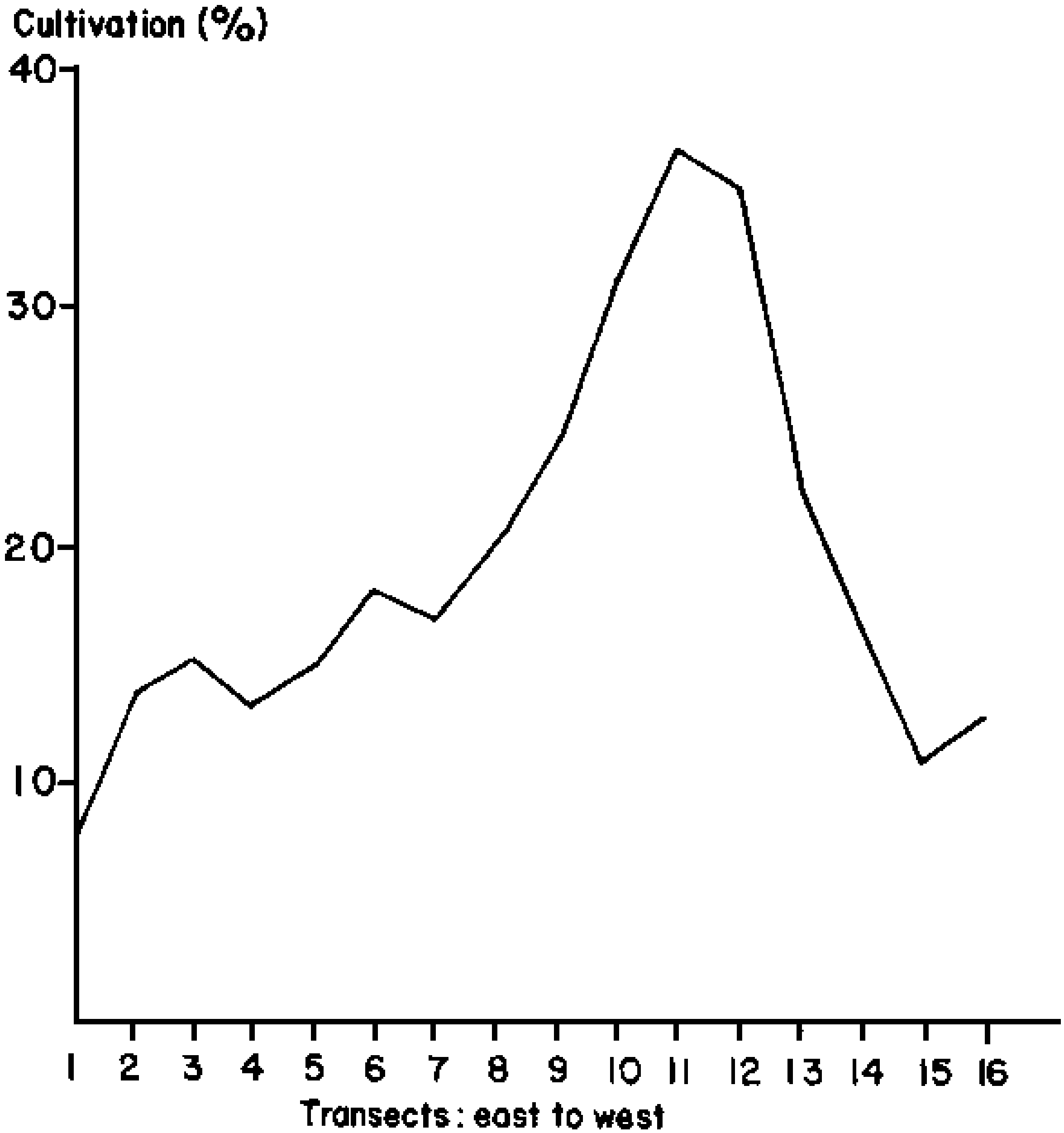


Table 3 shows the extent of various intensities of land cultivation in the subhumid zone and the cattle populations they are supporting. The table also shows projections of the number of cattle the zone could support if any particular intensity of cultivation becomes typical for the whole zone in the future. These projections peak at an overall average of 50% of the land under cultivation, but even at 70%, which may be the highest attainable level, the zone could still support the present cattle population (Bourn and Milligan, 1983). These figures are based on current land management practices.

Table 3. Present and projected cattle numbers at varying levels of land cultivation, Nigerian subhumid zone.

Land cultivated (%)	Land area ('000 km^2)	(%)	Present cattle Nos. ('000)		Projected cattle Nos. ('000)	
			Dry season	Wet season	Dry season	Wet season
0 - 9	136	38	955	546	2258	1426
10 - 19	76	21	857	955	3993	4456
20 - 29	38	11	478	611	4456	5704
30 - 39	26	7	290	360	4028	4991
40 - 49	26	7	406	411	5633	5704
50 - 59	20	6	311	238	5597	4278
60 - 69	17	5	265	154	5526	3209
70 - 79	17	5	180	158	3743	3298
Totals	356[a/]	100	3742	3433	-	-

[a/] Total land area surveyed.
Source: Bourn and Milligan (1983).

Table 4 gives a comparison of the changes in quantity and value of production that might be expected from increased numbers and/or productivity. The table suggests that even on the basis of small improvements in parameters such as fertility (raised to only 55%), production could be raised by 20%, which is equivalent to adding 680 000 head to the existing 3.5 million head of cattle in the areas surveyed by ILCA.

The orders of magnitude of potential returns suggest that there is scope for investment in research for increased productivity. At the same time the low output suggests that past research and development efforts have as yet had little impact at the producer level.

Table 4. Production matrix for different assumptions of cattle productivity in the subhumid zone of Nigeria.

	Protein (kg)[a/]			Value(N)[a/]		
	Present	Projected	Increase	Present	Projected	Increase
No. of cattle	**3.5[b/]**	**4.18**	**0.68**	**3.5**	**4.18**	**0.68**
Present productivity	10.69	12.77	2.08	385.4	456.72	74.32
Improved productivity	12.80	15.29	2.49	456.09	544.70	88.61
Quantitative increase	2.11	2.52		73.69	88.08	
Percentage increase	20	20		20	20	

[a/] All amounts in millions. One Naira = US$ 1.12.
[b/] 3.5 million cattle in surveyed area; 4.5 million cattle projected for whole zone = (1.3 x 3.5).

There are many interacting factors persuading pastoralists to settle and take up crop farming along with their traditional livestock husbandry (FAO, 1984). Whatever their reason for doing so, it would appear that the rate of settlement is increasing, yet the research results on which to base development programmes are wholly inadequate (von Kaufmann, 1983b).

Though settled pastoralists may be disdainful of the nomadic Fulani, their way of life and animal husbandry paractices are still much the same. Tradition is still a very strong force amongst settled Fulani and will certainly affect matters such as grazing management, and the quantity of labour and supervision they devote to livestock production. It will also influence their perceptions of the usefulness of any new intervention.

There is ample evidence (ILCA, 1979) that pastoral cattle breeds are capable of very much higher performance levels, if their nutrition is improved. Given the seasonally poor quality of the natural rangeland grasses (ILCA, 1979), cattle cannot be expected to perform at high levels of productivity without supplementation. Johnson et al (1977) determined that of all the possible changes improved nutrition would be the most effective in raising performance. Whether it be for beef or milk production, in a situation of scarce high-quality feeds the best returns are likely to come from feeding the breeding females (von Kaufmann and Otchere, 1982). Given the shortages of agro-industrial byproducts and other feeds, improved crop residue utilization and forage production on fallow lands (Tiver, 1979) will be essential to increased livestock production. Both of these imply integrated crop/livestock farming systems.

Pastoralists now settling in the subhumid zone can usually find land because traditionally most communities in West Africa acknowledge the right of all men to land for subsistence cropping. Finding land will, however, become increasingly difficult as the zone's population increases in the future. In these circumstances livestock production will grow only to the extent that farmers adopt mixed crop - livestock production and/or pastoralists integrate their own production system with the arable farming system. Before 1979 there was little understanding of how the existing systems were integrated, and even less idea of how this integration might be improved. The reactions of pastoralists to interventions must be fed back into research design. The settled pastoralists are part of the market economy and are subject to other outside influences, but the effect of government extension efforts to date has not been very great (except for veterinary services). Inevitably the success of any intervention will be as much determined by its appropriateness to development policies and extension capabilities, as by its inherent technical merit. Research programmes must, therefore, take full cognizance of the extension factor.

Objectives of the ILCA Subhumid Zone Programme

Since techniques for controlling the major pandemic diseases had already been developed, the 1979 state of knowledge review (ILCA, 1979) indicated that improving cattle nutrition should be given the highest priority in ILCA's Subhumid Zone Programme. It was clear from the outset that purchasing feed was not a viable long-term solution. There was not enough for current demand and its price would rise faster than the prices of animal products (Paper 21). Natural range grasses were of poor quality and the range was communally owned, often by non-cattle owning cultivators. Livestock owners must therefore learn to grow forage for themselves, but encouraging them to do so would depend on the availability of appropriate forage production techniques. There were no suitable forage production interventions available to the livestock extension services concerned with the subhumid zone in 1979. The overall objective of ILCA's Subhumid Zone Programme has therefore been to produce 'farmer-ready' forage production techniques to pass on to national livestock development and extension agencies.

Approach to research

To achieve the above objective, it is necessary:

1. To develop and test interventions that will enable ruminant livestock owners to produce (or obtain) and utilize efficiently more and better quality forage.

2. To ensure that forage research is backed by sufficient understanding of the environment in which interventions will be adopted. This, inter alia, requires an understanding of livestock productivity, animal health, the socio-economic circumstances of the intended beneficiaries and their perceptions of the interventions.

3. To maintain an agronomic research programme to resolve technical problems identified through intervention testing, and develop back-up and/or alternative techniques.

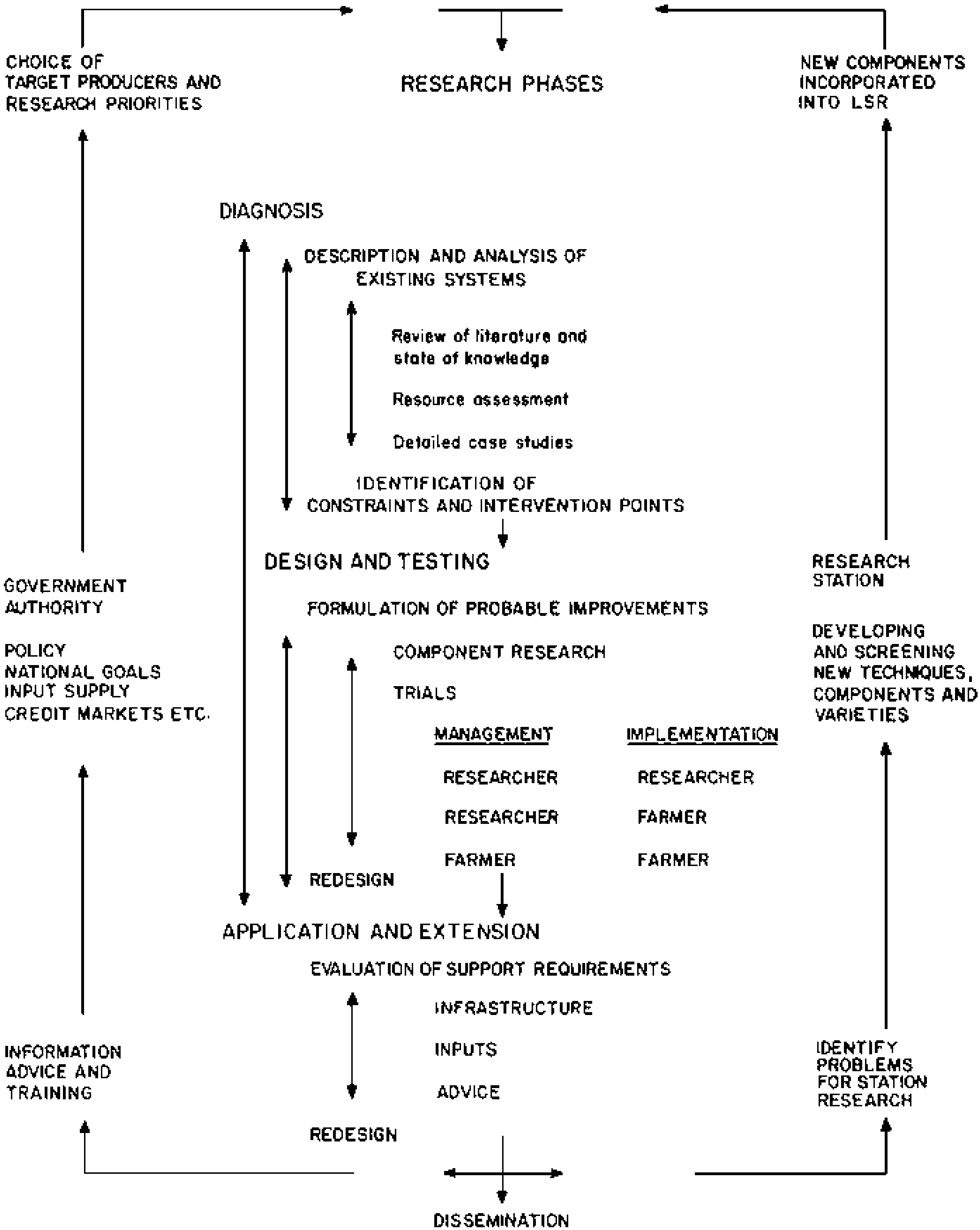
4. To transfer the LSR research approach to national research institutions so as to maximize the impact of ILCA's work over the long term.

The programme's work is carried out using a livestock systems research approach. The agronomic research is conducted along accepted on-station lines. The methods will be explained in more detail later in the symposium (Papers 14 and 15).

Livestock systems research

From the outset, the ILCA Subhumid Zone Programme has followed a livestock systems research (LSR) approach (Figure 5), developed from established farming systems research (FSR) techniques, but modified to suit the nature of livestock production and the particular research environment (von Kaufmann, 1983c). Dillon's (1973) summary of FSR applies well: "that man, not cations, or nodules, or rumen flora, or crop varieties, or livestock species, or dollars, consummates the system, must be a basic text." Dillon continues by stressing the need "to take a teleological view that effects may be due to the purposes they serve and only a holistic approach, with openness and teamness through interdisciplinary endeavour, can lead to the capturing of adequate understanding of a system for the purpose of improving performance."

Figure 5. ILCA Subhumid Zone Programme: Livestock systems research (LSR).



The settled agropastoralist is the primary user of the technology developed by the Subhumid Zone Programme, but given the close linkages between Fulani and arable farmer, both communities became part of the research effort. Lately, mixed crop - livestock farmers, who may be able to adopt some techniques more readily, have been included in the programme.

LSR as practised by the Subhumid Zone Programme involves concurrent phases of diagnosis, design, testing and application. Each phase interacts with the others in the continuing process of knowledge generation, intervention design, testing and re-assessment. Data are collected in increasing order of detail: i.e., zone as a whole; zone of Nigeria; case study areas in Nigeria; pastoral and arable households, herds, flocks, fields; and experimental herds and fields. Whenever possible, a single data pool is used to economize resources and to strengthen interdisciplinary research.

Diagnostic phase

The diagnostic phase involves the description and analysis of the existing system. This is includes animal production and health monitoring, household socio-economic surveys, crop - livestock interaction studies, ecology and grazing resource evaluation, and studies of decision-making and resource allocation within households. These activities are sometimes continuous, as with livestock production monitoring, and sometimes of limited duration, when time series data are not required. Diagnostic studies have been undertaken to provide information on the socio-economic and technical constraints in the system, to establish baseline data against which any innovation can be tested, and to provide data on specific aspects of the system which are expected to be affected by intensified livestock production.

After a ground survey and selection of case study areas, there was a need for global information about these areas. Systematic low-level aerial surveys were used to obtain a resource inventory. The surveys provided baseline information about the ecology, agriculture and inhabitants. Aerial survey techniques (Norton-Griffiths, 1978), further developed in Nigeria by the late Dr. Kevin Milligan and his colleagues (Milligan and de Leeuw, 1983), are now capable of yielding far more information, especially in regard to mixed farming, than was considered possible in 1979.

Design phase

The design phase involves the formulation of probable improvements based on identified constraints. Through close association with NAPRI, which has conducted livestock research in Nigeria for over 30 years, the Subhumid Zone Programme can capitalise on existing information and results in the design of innovations. Component research has included work on forage improvements through agronomic plot trials, on indigenous livestock production potential using the ILCA-controlled cattle herd and sheep flock, and on improved livestock production using ILCA-owned crossbred cattle maintained by pastoralists. This experimentation supports the formulation of improvement packages and the testing of potentially high-risk interventions.

Testing phase

The testing phase in the LSR sequence is linked with design and redesign. On-station and on-farm trials have been conducted on rationing of agro-industrial byproducts, undersowing and intersowing and inter-row sowing of legumes, establishing fodder banks, treating helminthiasis in calves, and increasing grain crop and dry matter yields in association with forage legumes. As far as possible, the Subhumid Zone Programme follows the FSR cycle, which includes:

1. Researcher-managed/researcher-implemented trials
2. Researcher-managed/farmer-implemented trials
3. Farmer-managed/farmer-implemented trials.

The final stage of farmer-managed/farmer-implemented trials hats been achieved with dry-season supplementation using agro-industrial byproducts and fodder banks, and with various crop agronomy improvements. An important aspect during the farmer-managed/farmer-implemented trials has been the evaluation of pastoralists' and farmers' reactions to the innovations, which are fed back into the research design as part of the effort to produce interventions that have a high potential for adoption.

Application and extension phase

The application and extension phase of LSR is perhaps the most critical, since it is at this point that the interventions move beyond the relatively small number of cooperating producers that ILCA can afford to work with. The Subhumid Zone Programme enjoys a close working relationship with the Federal Livestock Department (FLD) and the National Livestock Project Unit (NLPU), as well as with the Kaduna State Ministry of Animal and Forest Resources. These links with development and extension agencies have provided ideal circumstances for involving extension personnel in the research process and in the implementation of improvement packages. One concern is that innovations may be taken up by extension for dissemination before they have been fully tested. On the other hand, without the involvement of development and extension agencies it would not be possible to achieve enough replicates for analysis or to incorporate the objectives and requirements of extension. A delicate balance has to be found, which is only possible with good understanding and cooperation between development and research agencies.

The NLPU is currently extending two of ILCA's innovations: the rationing of agro-industrial byproducts to cows, and, on a limited scale, fodder banks, which are small pastures of improved legumes. ILCA is closely monitoring the rate of adoption of these two improvement packages as well as their implementation, since an important assessment of an innovation's appropriateness is whether, and to what degree, it can be extended by national agencies.

Justification and expected benefits

Sandford (1983) has stressed the efficiency of many traditional systems and the lack of demonstrable improvements under modernized or commercialized management. Although the production parameters determined for the settled Fulani herds monitored by the ILCA Subhumid Zone Programme are below the breed's proven potential, difficulties can be expected in achieving significant improvements in productivity.

The Subhumid Zone Programme is not, however, seeking to change whole systems. The interventions on which the programme is working are designed to meet a felt need of livestock owners and to be implemented with minimal changes. The programme is seeking to make changes with marginal costs relative to the total capital invested in livestock but which, if successful, will yield significant increases in productivity. The programme is also constantly revising its recommendations on the basis of controlled experimentation on components identified as problems through observation and feedback from producers and extension workers. The ultimate packages will thus have been jointly developed and tested by the scientists, extension staff and producers.

The programme's expected benefits are:

Producer level:

1. Improved cow productivity: milk yield, calving rate, calf survival, etc.

2. Better maintenance of soil capability for higher crop yields.

3. Improved feed resources and management to support more productive cattle, e.g. exotic crosses.

National level:

1. Increased producer awareness and extension contact.

2. Better information for development planning and execution.

3. Improved extension officer orientation and motivation.

4. More relevant research by national institutions.

Because grazing animals represent two-stage production systems with delayed responses on account of long generation intervals, the financial implications of changes in input - output relationships can best be tested by simple simulation models. Annual budgets are normally not adequate, because they usually only reflect 'before' and 'after' situations, and do not account for variations in cash flows. Moreover, they cannot always be readily applied to assess the sensitivity of various cost - benefit criteria to changes in technical relationships.

The models need not and, indeed, should not be complex. The objective of LSR is to serve the livestock producers; and the producers, particularly if they are poor, are averse to risk. They will only be interested in interventions that offer major contributions to the achievement of their goals. LSR is also intended to be cost-effective, and this cannot be achieved by the relentless pursuit of minutiae.

Some models will be discussed in a later paper (Paper 21) following explanations of production systems and the technical features of the interventions. At this stage, it is important to be aware of the need to synchronize all steps from data collection through technical interpretation to economic analysis. That is, interventions must promise to be technically feasible, socially acceptable, financially viable and economically defensible. All these criteria must be periodically checked so that unpromising lines of research can be dropped and more fruitful areas pursued more vigorously. It is not adequate merely to provide 'before' and 'after' evaluations.

More details on the implementation of an LSR programme are given in von Kaufmann (1983c). The implementation of such a programme in the subhumid zone of Nigeria was, and remains, dependent on the conviction that the zone offers opportunities for finding technically feasible interventions that will promote producer welfare. The evidence at the moment is that the subhumid zone does offer the potential, but it will only be successfully tapped by a holistic, multidisciplinary and sustained research effort.

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